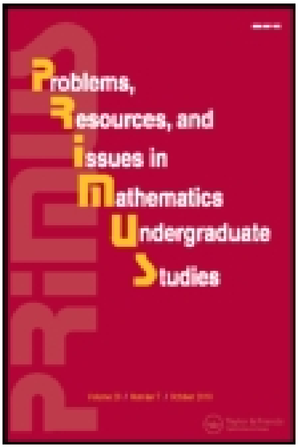

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Transitions from Live to Online Teaching

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Eileen Fernández

Abstract: The current manuscript is a reflective case study that describes the emerging design of the author's first online mathematics course. The case study addresses how expectations associated with teaching in a live setting can raise conflicts in designing online courses. The author reframes the conflicts into questions; explores the questions and related resources; and describes one possible model for an online mathematics course. Student feedback on the written materials, teaching, and assessment developed for the online course are discussed.

Keywords: Online mathematics teaching, critical thinking in online teaching, technology in teaching, general education mathematics course.

1. INTRODUCTION

When I taught my first online mathematics course, I decided to keep a journal of the experience. One issue that arose concerned the differences between teaching an online course and a live course for the first time. How would my experience with live classes influence my approaches to online teaching? How would my students' experiences with live classes influence their expectations for an online class? While inexperience with online teaching can suggest a fresh start, it is possible for expectations from live classes to raise conflicts and questions in this new setting.

In this paper, I begin by describing the online project I was assigned, the course and students, and my philosophies for teaching mathematics. I then describe questions that arose for me as I considered *materials*, *teaching,* and *assessment* in an online environment. In cataloging these questions, a *case study* [13] emerged that details how my online course was organized and developed. This case study:

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- uncovers how expectations related to live settings can influence thinking in online teaching;
- demonstrates how to reframe obstacles against online teaching into questions for exploration and discussion;
- describes how these analyses were framed into one possible model for online teaching.

I conclude with descriptive statistics from my students about the course's materials, teaching, and assessment.

2. BACKGROUND ON COURSE, STUDENTS, AND TEACHING PHILOSOPHY

Our mathematics department embarked on an experiment to teach two mathematics courses online: a 100- and 400-level course. This paper concerns the 100-level course—a general education class entitled Contemporary Applied Mathematics for Everyone. The course objective is "to expose students to aspects of mathematics that are useful in everyday life," with the professor given free reign on how to do this. I had taught this class, live, several times and designed it from scratch. My approach focused on modeling with spreadsheets with the mathematics covering money growth and investment.

Most of the students who take this class are mathematically anxious and taking the course solely to fulfill a college-level mathematics requirement. To them, mathematics need not make sense as long as there is a well-defined path with reproducible steps toward the one correct answer. These views conflict with my own vision for teaching mathematics, which includes developing problem-solving autonomy and collaboration, encouraging critical thinking, exposing students to the full spectrum of mathematical thinking (from straightforward calculation to open-ended investigation), and giving students the mathematical tools and disposition to help them interpret and enrich their lives. I began my online experiment with a comparable class of students, my teaching vision intact, and a set of handwritten, bulleted notes from my live classes that had evolved over multiple semesters of use.

3. MATERIALS

Online environments provide a variety of options for content delivery. Online versions of textbooks, articles, or notes continue to be a fundamental part of the package as teachers consider these options.

Teachers' and students' relationships with materials in live and online settings can be different. In my case, I had a set of notes I had used as a guide for live classes. Using the notes as a guide means I try to incorporate students' questions, observations, and dilemmas when I teach with the notes. In particular, I invite students to revise planned solutions through our discussions and to play a part in creating and recording new solutions and new notes. Writing notes that could be revised by student input was one of my goals in producing online written materials. In particular, I hoped to uphold the expectation that students participate in creating our notes through their question posing, observations, and dilemmas.

But this goal raised questions: how can a teacher foster the interactions and responsiveness of live problem-solving in online settings when online settings can restrict learning to a student working alone with written materials (sometimes called "learner-content" interaction [5])? This issue was further complicated by the knowledge that students do not typically read in mathematics classes [11, 8]. Thus, in a discipline where students are unaccustomed to learning from reading, it can appear that an environment that necessitates independent reading may be problematic.

These goals and dilemmas led me to the literature on reading and mathematics [1, 2]. In particular, the *transactional model of reading* guided my development of the kinds of materials that could enhance interaction between a reader and his or her materials. This reading model is grounded in the perspective that ambiguity will occur during reading, that (student) thinking originates in such doubt, and that the act of searching and inquiring to resolve the doubt enables the student to generate new meaning and knowledge [1].

With these ideas, I developed devices for my online notes. To disassociate reading the notes from reading textbooks, I excluded features like single spacing, marginalized diagrams, and skipped steps. In addition, I adopted a first-person approach to simulate a dialogue between the student and myself and wrote paragraphs instead of bulleted lists. And in contrast to textbooks' dual audience of teacher and student, I wrote with the *student* as the sole intended audience. To encourage the ambiguity-resolution process described in the transactional model, I posed questions and left ample space for students to respond. Elicitation of multiple approaches and the use of inductive reasoning and patterns could further encourage student responsiveness to materials. Online settings facilitated incorporation of these features since constraints like space limitations did not hamper my efforts. A set of notes ranged from 7 to 21 double-spaced pages. Notes were saved as PDF files to preserve mathematical formatting.

In general, the use of written materials in online settings challenges teachers and students to re-examine how to bring responsiveness to the role of reading in learning mathematics. Thinking of reading as an activity that "requires some active and generative effort on the part of the student" [1, p. 13] can serve this re-examination. When students work independently, reading in an online setting provides an opportunity for a *student-centered* search for clarification in the teacher's absence. Because the vulnerability that sometimes accompanies confusion is privately experienced, it could encourage risk-taking. Out of necessity, students could learn to create their own personal meaning for the kinds of mathematical processes and thinking that underlie written text and make sense of what is confusing them. This autonomous aspect of learning should not preclude providing inter-personal support (see next section on Teaching). Nevertheless, an online environment can more actively involve students in the more independent aspects of problem-solving that teachers struggle to promote in more traditional, live settings because of the traditional expectations associated with those settings.

4. TEACHING

As explained above, my students had been indoctrinated into a model of mathematics teaching and learning in which the teacher teaches a new skill or concept, the student imitates and practices it, and the teacher assesses it. However, my vision for online (and live) courses conflicts with this expectation and when this conflict arises, it can introduce additional challenges for a first-time, online teacher.

From my live experiences, I had learned to rely on regular and frequent meetings to encourage my vision for learning mathematics and to support students through the struggles and apprehensions this can produce. Balancing flexibility and autonomy in student learning, support for students, and my vision for teaching generated unprecedented questions concerning online teaching. Should I be thinking about teaching students who were not required to be on campus at a set time? If so, how would I teach them? Should I make the meetings mandatory? Could I teach in a way that supports students who struggle with my vision of mathematics teaching? What would be the content of our meetings? I even struggled with technical issues, like how to represent mathematical symbols and share the spreadsheet technology with students through my online teaching.

These goals and dilemmas led me to research my institution's technological support: the Learning Management System called *Blackboard* and a synchronous online conferencing program called *ElluminateLiv*e [3]. I decided to post weekly *modules* containing my online notes and assignments on *Blackboard*. Students would download the modules and each module would be due on our assigned weekly meeting day and time. Thus, students would have to read the notes and solve problems by a stipulated deadline. Also, I would offer an online class on *ElluminateLive* at our weekly meeting day and time. To provide flexibility, I offered choices: if students felt they had mastered that week's material, they could skip the online class. If they had questions, they could attend the class and their questions would guide class content. If some students wanted to attend class, but could not make it, I would use *ElluminateLive*'s recording feature to record each class and post the recording on *Blackboard*. In this way, study time flexibility was upheld, but a resource existed where students could pose and resolve questions with teacher guidance. Even non-attending students could view the recording making it a window into the kinds of collaboration and problem-solving that *all* the students should be learning.

Other issues resolved themselves. Because *ElluminateLive* has an application sharing feature, I could use a spreadsheet to communicate the course technology and equation editor to create mathematical symbols within the program's viewing window. These features were important given the course's use of a spreadsheet and my focus on upholding the integrity of mathematical representations. With the program's capacity to turn over privileges to students, students could enter information onto a displayed spreadsheet, draw pictures, or create equations. The program's capacity to create groups of students also supported my views on student participation. Finally, the ability to record my lessons would provide opportunities for viewing and re-viewing of lessons in students' own time frame.

The reflections on my teaching also led me to consider whether reading is always the best way to process content. Thus, I decided to create podcasts and videos with links directly embedded into the notes [4, 6]. These materials provided another vehicle for teaching and communicating mathematics in a dynamic and interactive fashion. I did not include myself in the videos, but used techniques used in the online notes, like asking questions or exploiting patterns, so students could process these same techniques via a different medium. The interested reader may view two podcasts at: http://flywheel.csam.montclair.edu/~fernandez/Module4Podcasts/Podcast/Podcast.html.

In general, I made unanticipated, but meaningful, discoveries from considering issues related to online teaching. First, while using the equation editor on *ElluminateLive* slowed my pace in writing mathematical expressions, students reported that this pace helped them process information. Running my classes as a forum for raising and responding to questions changed class content, and my teaching, dramatically. The "sage on the stage" expectation for teaching diminished as I reiterated and adhered to my maxim: no student questions, no online lesson. This enhanced my teaching vision as I found it easier to assume the role of "coach" or "moderator," orchestrating ideas, raising important questions and helping students make the best of resources [12, pp. 13–14]. Consideration of teaching issues brought my online notes to their final form, with written text based in the transactional model of reading and embedded videos conveying information that was challenging to write. More importantly, all concerns regarding teacher/student and student/student interaction, student exposure to my philosophies, and student flexibility for study time were mitigated. Considering issues related to online teaching generated a more innovative role for me that helped to support my more general philosophies for teaching and learning mathematics.

5. TESTING AND ASSESSMENT

In a setting where I would not see students on a regular basis, the topic of *assessment* raised multiple issues. These included *summative* issues like testing and more *formative* ones like monitoring student progress, using assessment to make instructional decisions, and evaluating the course as I taught it [9].

In my live course, testing typically involves two in-class exams, bi-weekly quizzes (taken individually or in pairs), and a final exam or project. My supervision of these exams and quizzes mitigated the biggest fear I had for online assessment: student dishonesty and cheating. How could I guarantee that a student taking an unsupervised test or quiz online did not have someone assisting them or doing the assessment for them? Pacing was another issue: if students learn material at their own pace online, should I enable them to take tests or quizzes at their own pace? If one student completes the material for an exam or quiz early, should I provide the student an opportunity to take the exam or quiz early? How would assessments be returned? Individually or collectively? In live classes, collective feedback can illuminate good criteria for problem-solving and material presentation, sometimes in a way that is not illuminated during class. And the issue of cheating again rears its ugly head since administering and returning exams or quizzes before others take them puts the materials into circulation.

Unfortunately, without a proctored testing center at my disposal, I found no resolution to the issue of cheating in an online setting. Thus, my online class became a hybrid one as I mandated students come to class on two days to take exams. Quizzes were take-home and assigned and submitted electronically. They were done individually or in groups with *ElluminateLive* providing a mechanism for students to meet without having to be in the same physical location (the program enabled me to create accounts for selected groups of students). One deadline was stipulated for each quiz, thereby minimizing the disorder that could result from monitoring multiple quiz dates and return of materials. This approach enabled me to post solutions with point allocations and report summaries via *Blackboard* about class performance, common errors, and exceptional approaches. For the final, I experimented with a format that was part take-home and part oral. Students were given a take-home project and then came to my office individually at a designated time, during which, I asked questions about the take-home. This turned out to be an especially rewarding learning experience and a fitting conclusion to closing out the class on an individual basis with each student.

What if I considered more formative aspects of assessment, as "an integral part of instruction that informs and guides teachers as they make instructional decisions" [10, p. 22]? In a live classroom, my questions can be met with redirected stares and silence, reflecting student confusion or discomfort; student questions, demonstrating courage or ability to articulate a lack of understanding; or student-to-student interaction, reflecting autonomy from the teacher and independent problem-solving. Such indicators can influence a lesson's direction with different consequences for teaching and learning. Their absence challenges teachers to come up with new mechanisms for encouraging, and responding to, student feedback.

To monitor this, I planned to use the student questions guiding the online lessons. Although I did not anticipate full class turnouts, my goal was to use questions posed as an indicator into student understanding and the clarity of my notes and problems. *ElluminateLive* also provides student cues for communicating understanding (smile face) or struggle (frown face). To share observed trends in student understandings and struggles, I utilized the fact that I was posting lesson recordings on *Blackboard* and accompanied each post with a description of issues that arose during that lesson. In this way, non-attending students also would have an opportunity to experience how their peers' questions informed my instructional decisions and how these decisions, in turn, influenced learning and interpretation of materials. Finally, e-mail served as a window into student thinking by providing feedback on how materials were processed.

Although my decision to give live exams shortchanged student flexibility, it upheld the validity of test results. In addition, the use of multiple sources of evidence for student learning (written take-home quizzes, written in-class exams, combined take-home and oral final) "allows for strengths in one source to compensate for weaknesses in others" [9, p. 19]. Thus, the variety in assessment sources could optimize students' opportunities to display their learning using one preferred mode or setting for assessment.

6. ONE MODEL FOR A HYBRID MATHEMATICS COURSE

My research generated a model for a hybrid mathematics course that enabled me to adhere to my teaching and learning philosophies in a new environment (see Figure 1).

The overlap topics serve dual purposes. For example, the podcasts, videos, and recorded lessons emerged from reflections on my teaching, but they also are materials.

7. COURSE EVALUATIONS

Since the Spring of 2010, I have taught this course four times. To elicit student feedback, I designed a survey and an open-response questionnaire that were administered to one semester's 26 students. Given the small sample, this section contains no high inference analyses, but descriptive statistics and analyses to give the reader one snapshot into the students' experience.

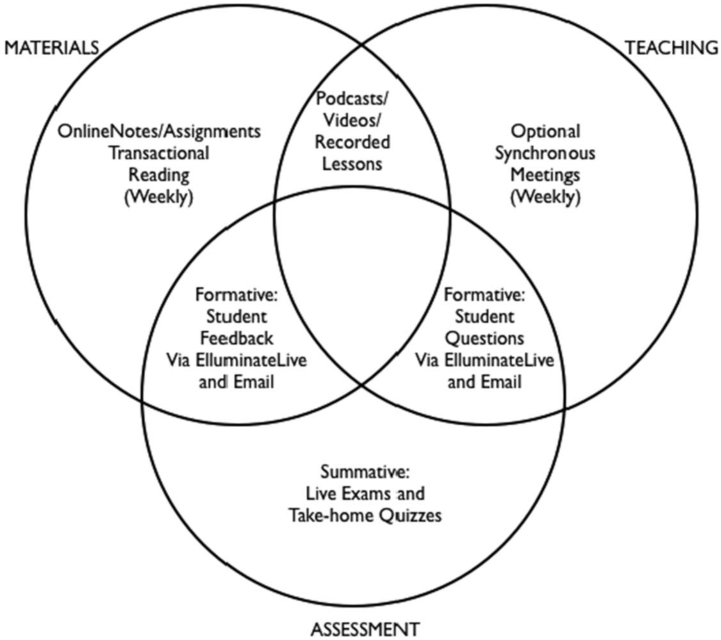

Figure 1. One model for a hybrid mathematics course.

As each student completed their final in my office, I gave him or her a survey and a questionnaire to fill out in the main office and leave in a marked folder. Focusing on the survey, I asked students to consider the class materials' *utility* and *helpfulness* and students' *self-reliance*. For example, for the Module Notes, the survey statements were:

I read the Module Notes to help me learn the course material. (*Utility*)
I found the Module Notes helpful in learning the course material. (*Helpfulness*)
I understood the Module Notes on my own (without outside assistance). (*Self-Reliance*)

Students rated these statements on a scale from 0 (Never) to 5 (Always) with the option "Not applicable" in case, for example, they did not read the notes. Table 1 summarizes mean responses for each resource developed.

In addition to the reported means, the mode for each item was a 5, substantiating these students' overall positive experience with materials. The table indicates the module notes were the most helpful resource in enabling students to learn the course material, suggesting a "utility" (4.77) and "readability" (4.96) not typically found for reading materials in mathematics courses [11, 6]. The measure on students' abilities to learn from the notes without outside assistance is lower (4.32) and suggests the need for revising the notes or for additional help in this course with this teaching model.

Table 1. Student feedback on online materials

$n = 24$[1]	Utility	Helpful	Self-reliance
Module notes	4.77	4.96	4.32
YouTube videos	4.55	4.91	4.91
Podcasts	4.4	4.75	4.25

[1]There were 26 students in the class. However, two students' ratings were contradictory: on their survey items, *every* item response was rated "0" corresponding with "Strongly disagree" (and a negative experience). However, open-ended responses were entirely positive and even contradicted survey responses (indicating a positive experience). Because this contradiction compromised the validity of their responses, these outliers were omitted from this analysis.

To assess teaching and support for students, students were asked to respond to utility and helpfulness ratings for online sessions attended and recorded lessons. As expected, the option to skip online sessions resulted in 16 of 24 students saying they attended an online session (not necessarily regularly). Of these 16, the sessions' helpfulness mean was a 4.44, indicating a strong measure of helpfulness to students who took advantage of this resource. This can also be interpreted as a positive response to the use of students' questions to orchestrate and guide teaching. For the recorded lessons, 21 of 24 students indicated making use of the recordings with a helpfulness mean at 4.29. In addition, students reported feeling "encouraged to ask questions" by their instructor (via e-mail or *ElluminateLive* sessions) with a mean response of 4.62. And the "instructor's responsiveness to students' questions and difficulties" had a 4.75 mean. Although the sample is small, these responses suggest a consideration of some form of teaching support for students learning with this model in online settings.

On the topic of testing and assessment, students agreed that "tests, quizzes and assignments reflected the material taught" (mean of 4.75) and also described being "evaluated fairly" (mean of 4.75). No adverse feelings were reported on my decision to administer live exams. Finally, special issues related to online teaching are reported in Table 2. The responses again served

Table 2. Miscellaneous measures on student learning

$n = 24$	Statement	Mean
	I was actively involved in learning course material.	4.63
	I was motivated to work hard by what we did in this course.	4.5
	I kept up with course material and submission deadlines.	4.5
	I learned new material in this course.	4.67
	I was encouraged to think critically in this course.	4.67

to quell my worries over students keeping up, learning, or thinking critically in an online environment.

8. CONCLUDING REMARKS

The model presented is one *possible* model for teaching and learning mathematics online. However, my intentions are less about promoting the model than about encouraging the reader to develop his or her own model. Consideration of such factors as materials, teaching, and assessment can provide one step toward the reader developing a model. For me, this process revealed hidden assumptions about the teaching and learning of mathematics that I had never considered in live settings. For example, developing reading materials for my online course revealed the dual readership implicit in textbooks, enabling me to write materials focused on students. Consideration of teaching issues revealed the possibility of a teaching model that enhanced the student role in a way I never considered in a live setting by orchestrating entire classes based on student questions. I also realized that institutional support for assessment could have helped me to uphold the integrity of testing in an online setting. Nevertheless, my reflections opened up my course to new and more diverse methods of evaluation (like in-class, take-home, and oral examinations).

In contrast to presenting finished models for online teaching [7], this paper describes the process leading to one model. It catalogues conflicts that can arise in transitioning from live to online settings, solutions discovered in the literature and technology, compromises, and reasons for the compromises. It is hoped that recording these issues will assist those readers considering online teaching formats. In conjunction with the students' positive responses to the course, it is additionally hoped this portrait persuades the reader that online methods have a constructive place in students' learning of mathematics and a possible place in the reader's teaching of it.

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BIOGRAPHICAL SKETCH

Eileen Fernández is an Associate Professor in mathematics education at Montclair State University. She is interested in all matters related to undergraduate teaching, teacher education, and experimentation with teaching settings (including online teaching).